GPU-Based Muon Segment Seeding for HL-LHC Reconstruction

CERN openlab Summer Student Programme Lightning talks

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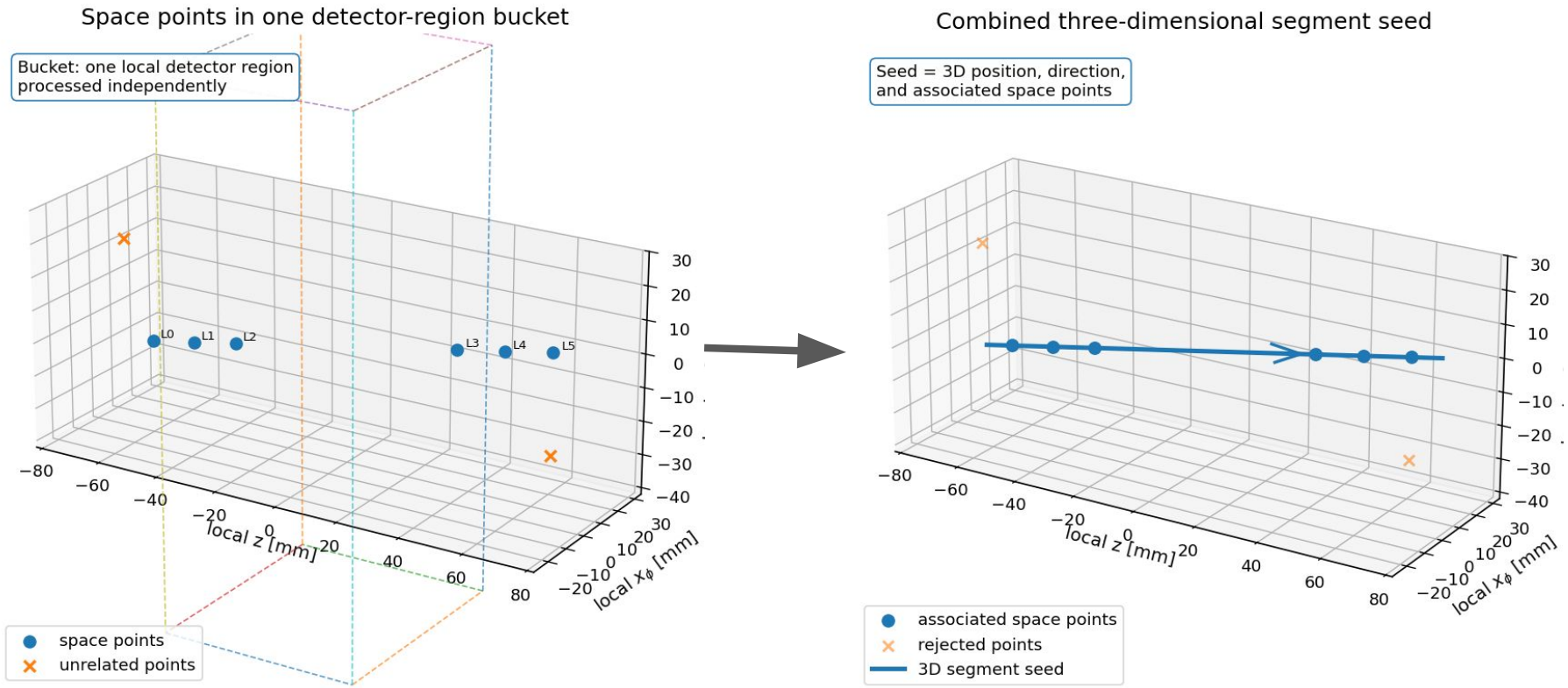
Supervised by: Johannes Junggeburth

Introduction

This project implements Eta and Phi segment seeding as an ACTS example and potentially traccc in the future. Project is benchmarked for physical and computational performance.



Scope and Research Question

Can a GPU implementation provide similar level of physical performance while speeding up computation in relation to hardware cost?

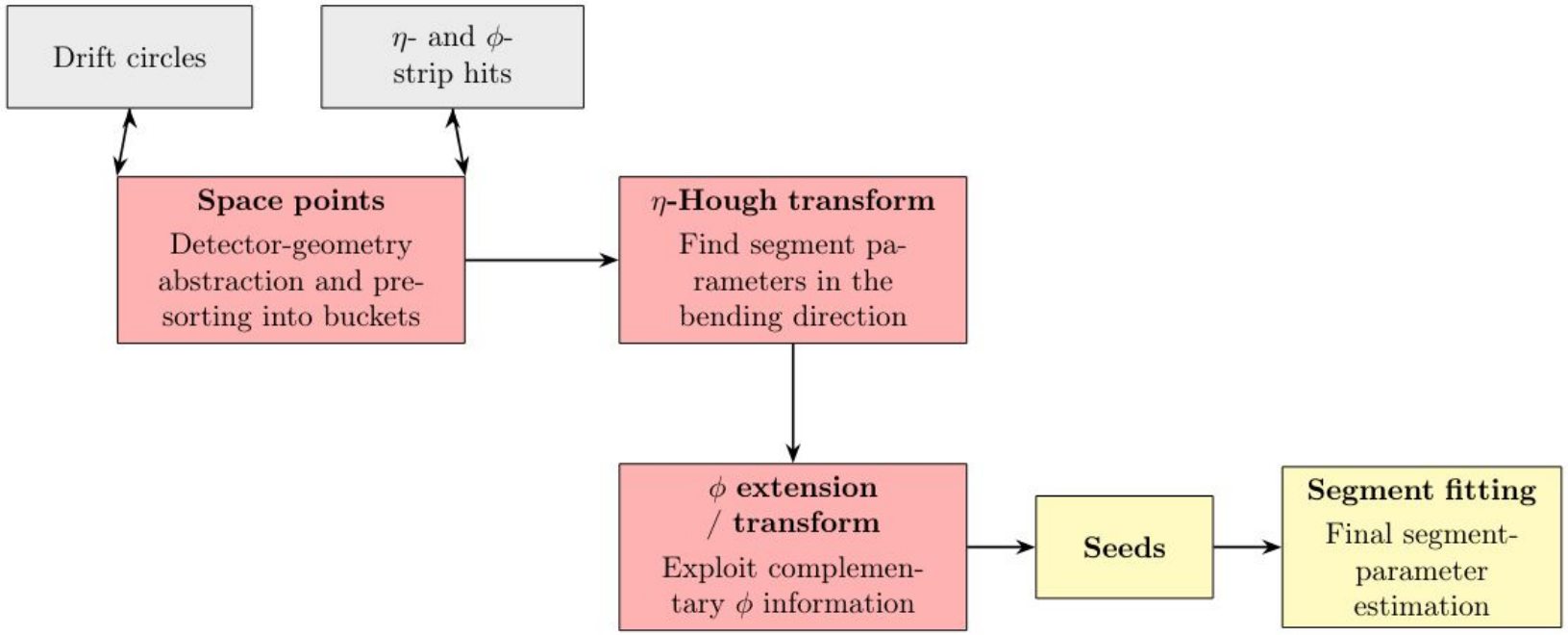
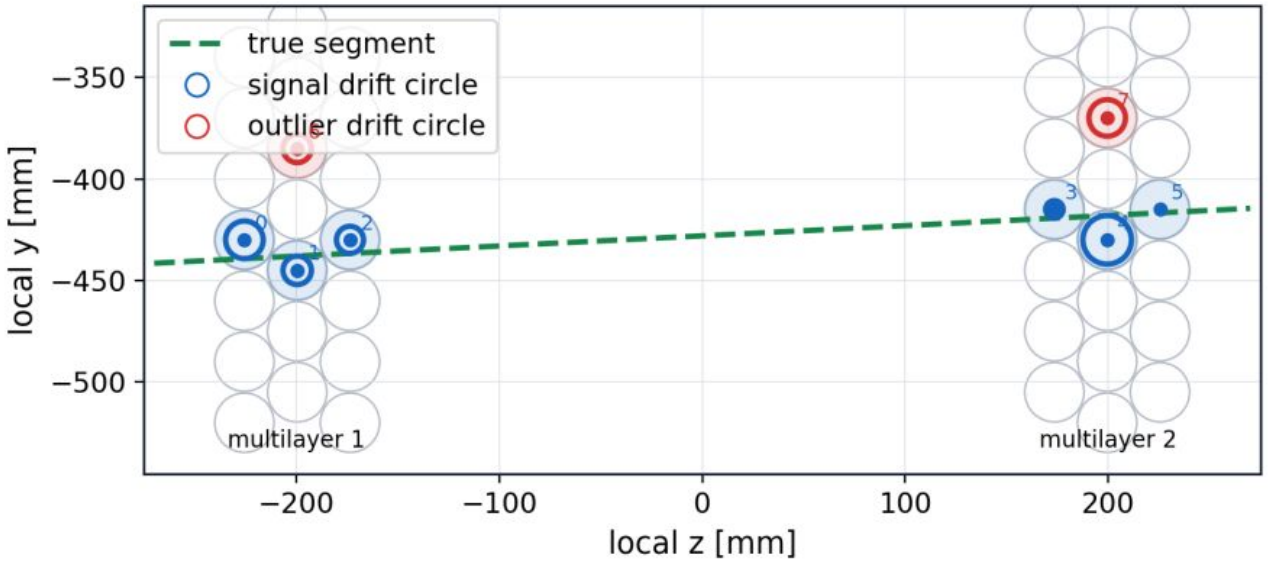


Figure 2: Simplified flow of muon pattern and segment finding considered in this project. Red boxes represent parts of codebase, which implementation was in scope of the project. Seeds and segment fitting highlighted in yellow have prototypes, but need further work.

Algorithm Description -> Hough Transform

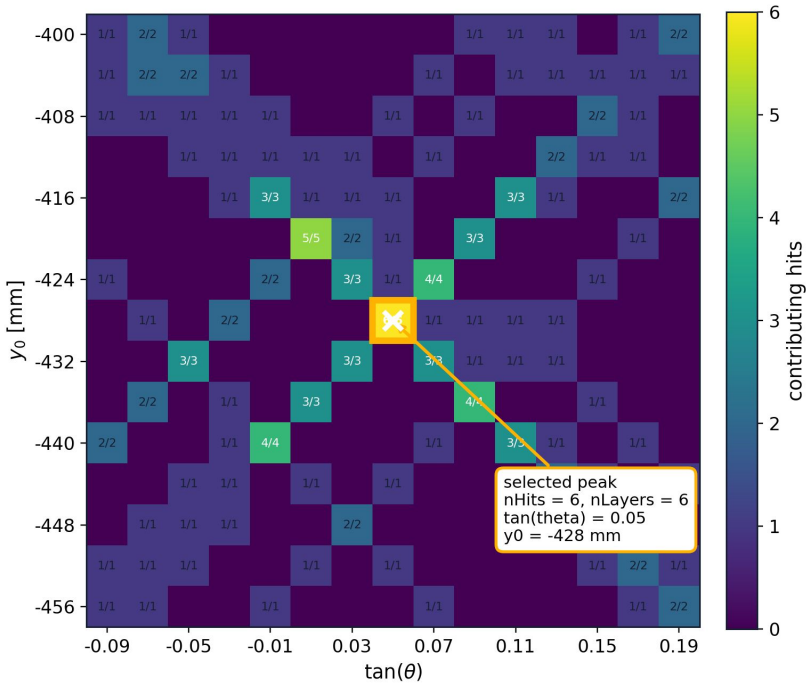
Point := (z_m, y_m)

$$y_m = a * z_m + b \pm r * \sqrt{1 + a^2}$$
$$b = -a * z_m + y_m \pm r * \sqrt{1 + a^2}$$



b

Hough Plane

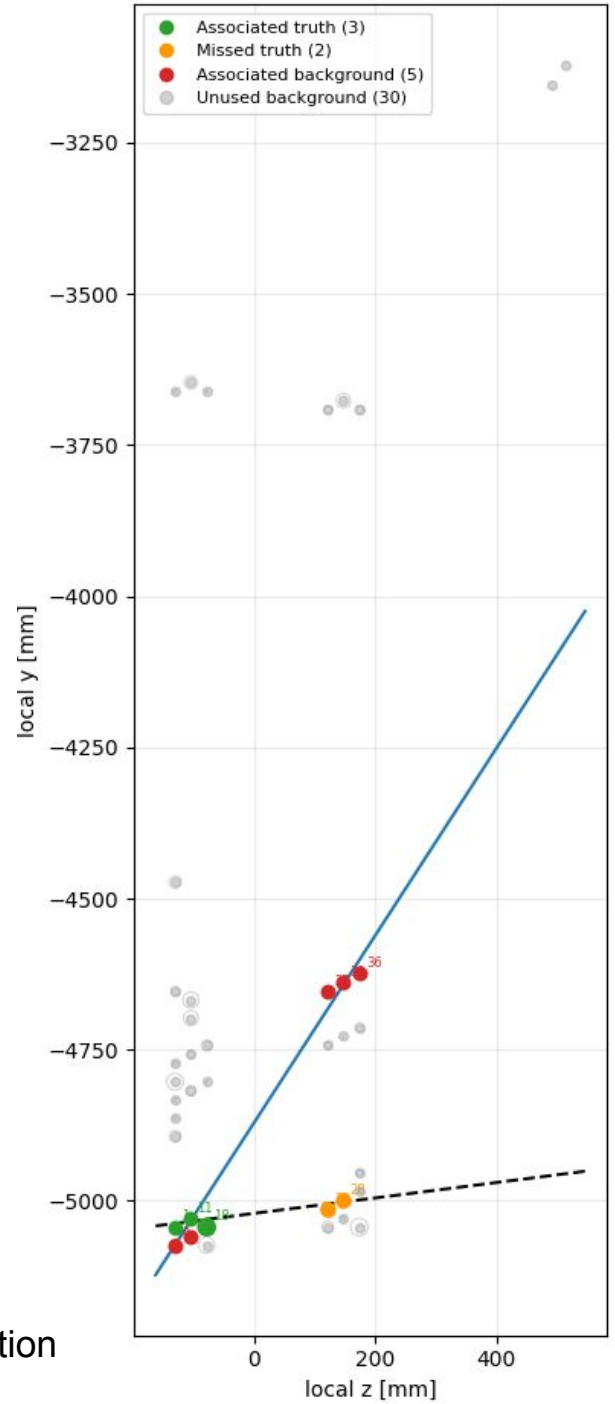


a

Test Cases

Table 1: Sizes of the three validation inputs passed to the Hough transforms.

Quantity	Straw generator	Particle_Gun_MU0	Particle_Gun_MU200
Events	5 000	50 993	12 000
Physical buckets	5 000	371 873	5 788 951
Space points	107 651	4 994 780	73 986 372



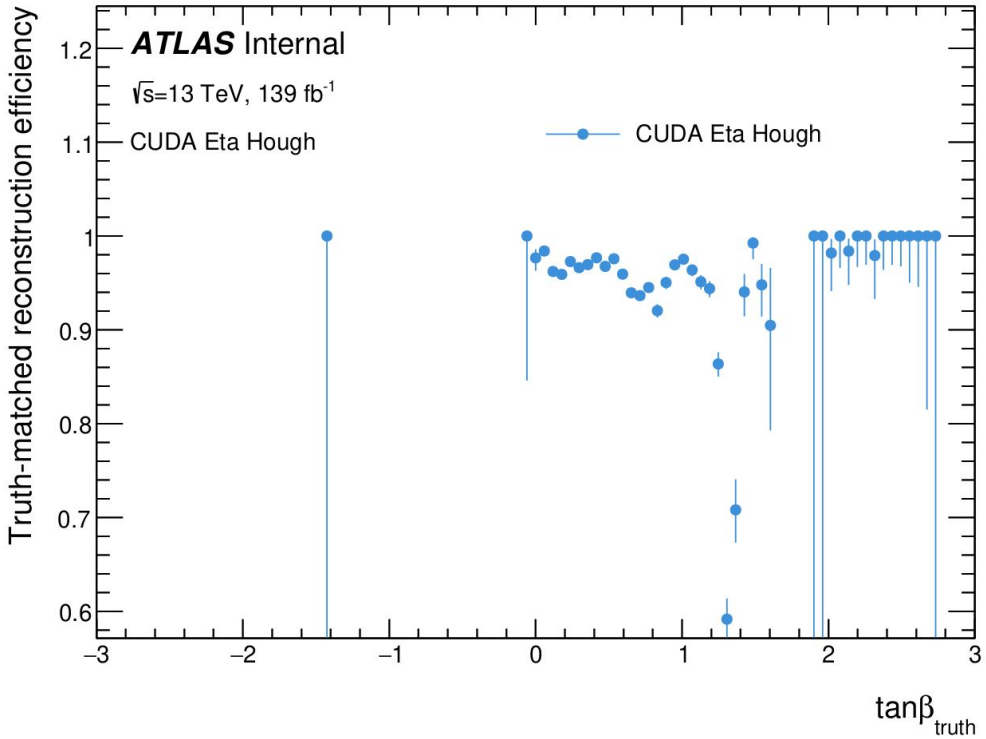
Results -> Physical Performance

Sometimes better sometimes worse

CPU

Max finding eff = **99.08%**

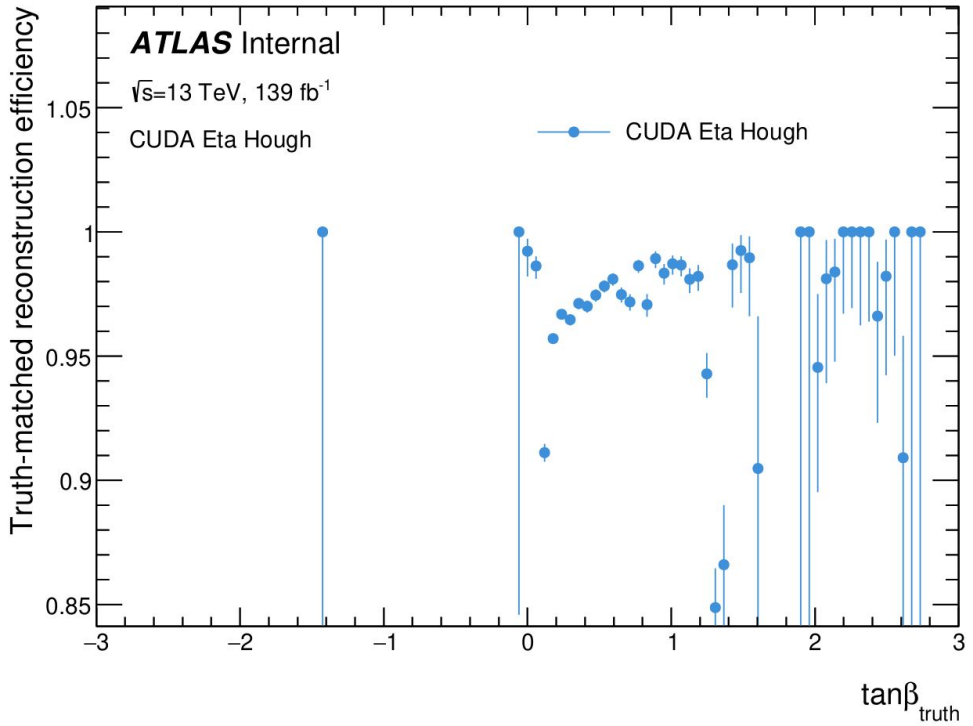
>=4 truth hits = **95.85%**



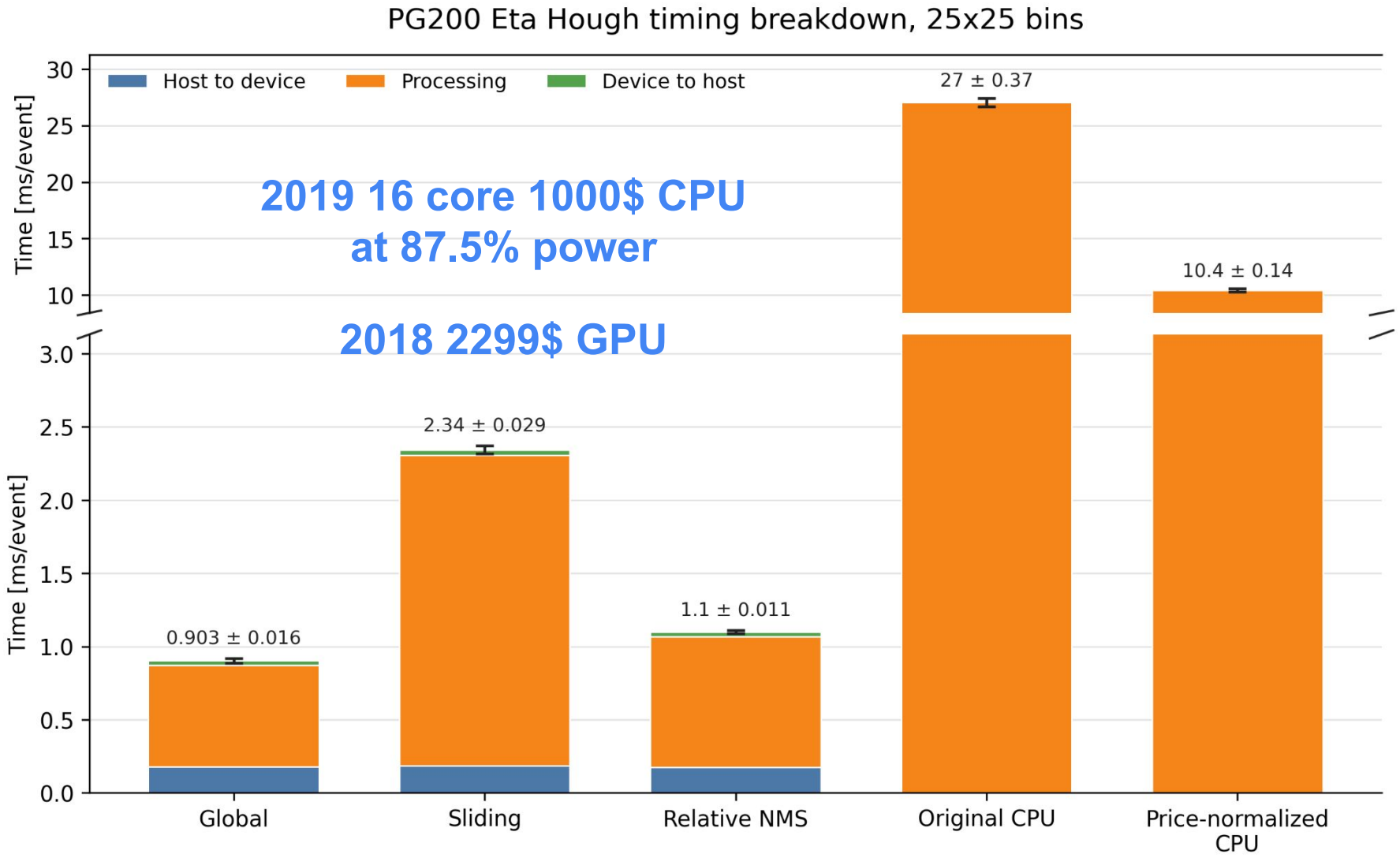
GPU

Max finding eff = **99.91%**

>=4 truth hits = **96.45%**



Results -> Computational Performance

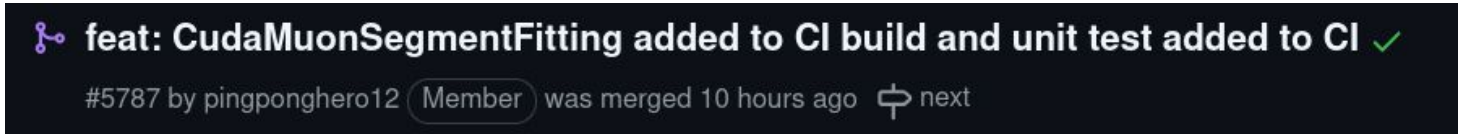


Conclusions and Future Work

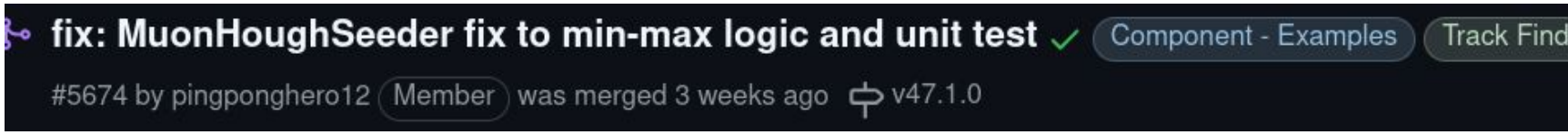
GPUs could be worth exploring for ***muon segment finding***:

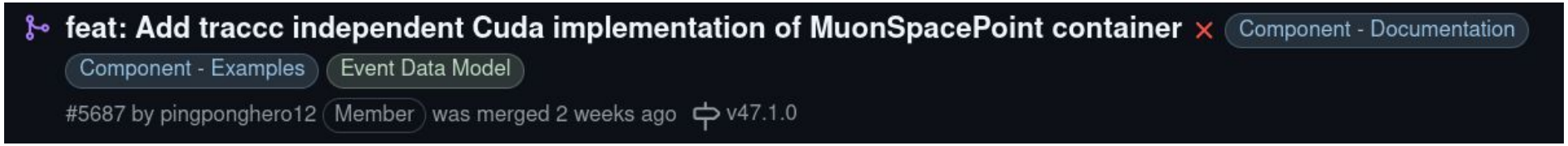
- Initial study shows a ***potential computational improvement***
- Provides ***good physical performance***

Future work:



1. Implement Phi transform.
2. Commit rest of the project into ACTS/traccc
3. Segment fitting





Thank you for listening!

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Backup Slides

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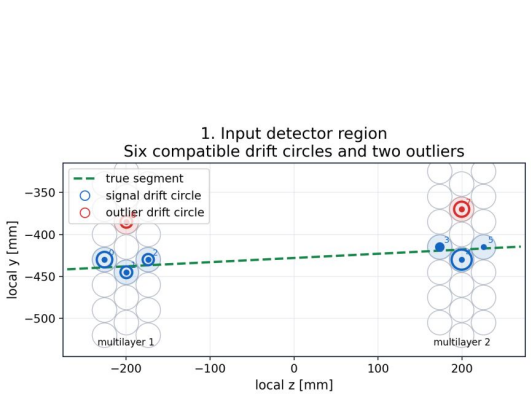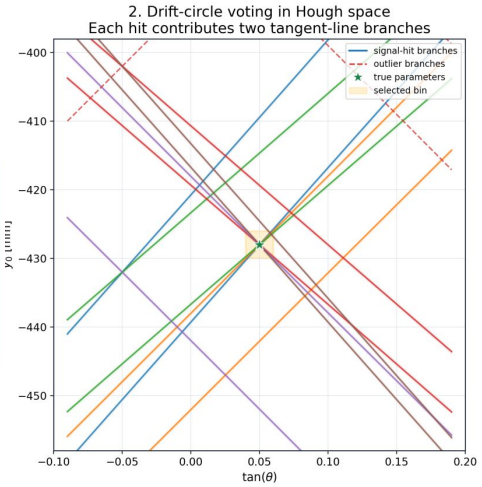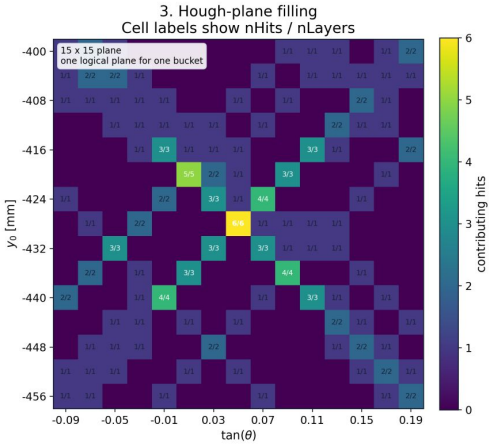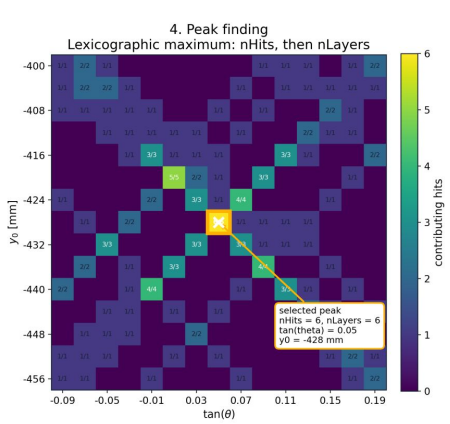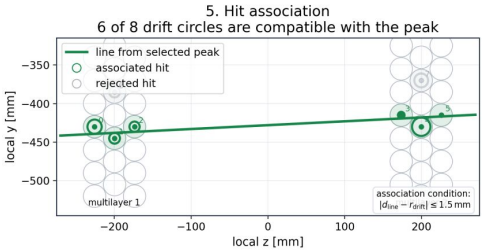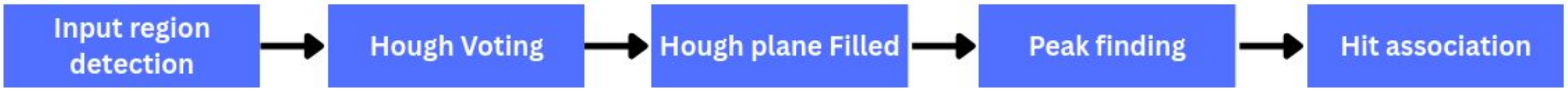
Results -> Physical Performance